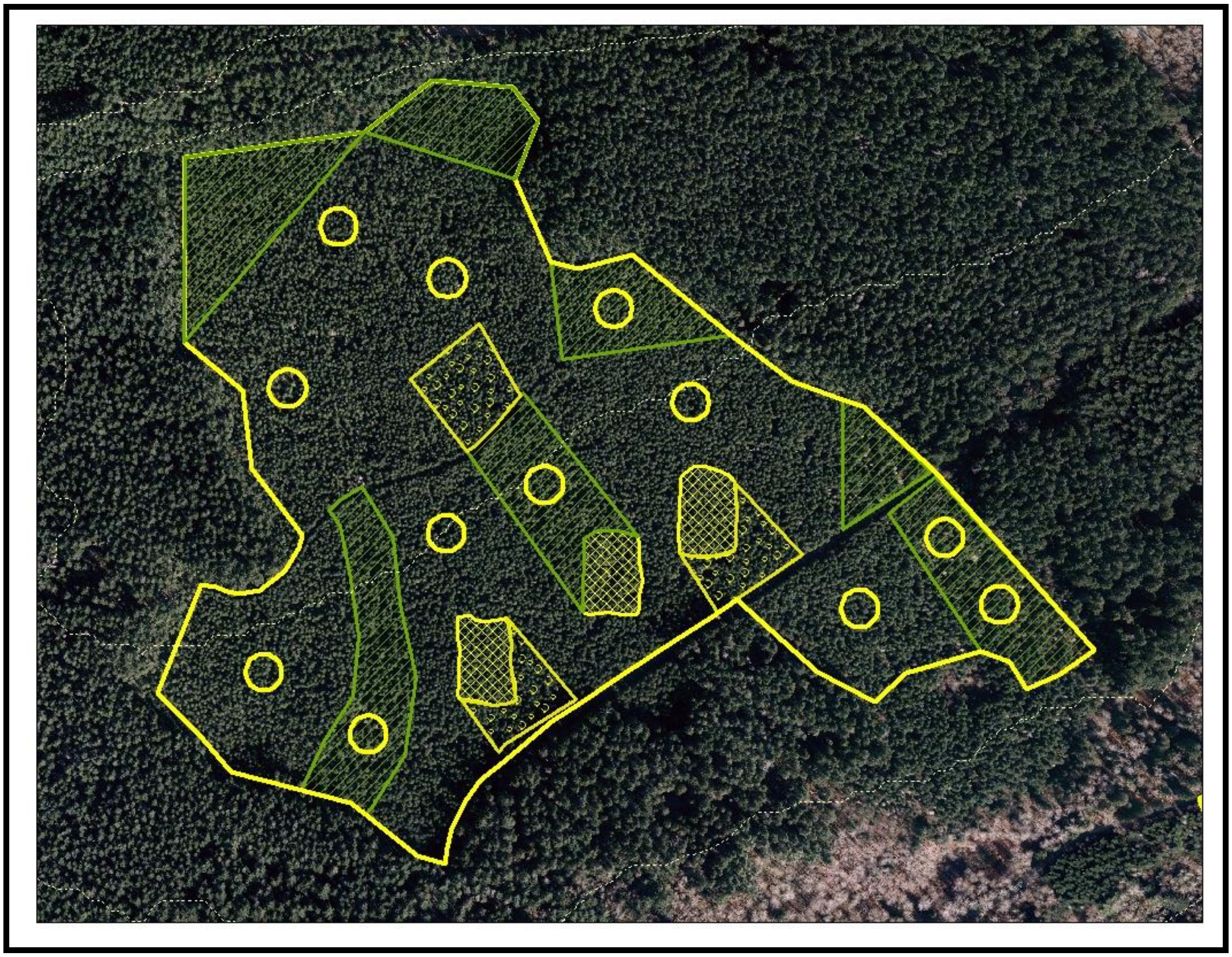
Barneston
Forest Habitat Restoration Project

June 2015



Bill Richards
Rolf Gersonde
Amy LaBarge
Wendy Sammarco
Sally Nickelson

Seattle Public Utilities
Watersheds Management Division

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1.0 PROJECT GOALS AND OBJECTIVES

The goal of the Barneston Forest Habitat Restoration Project is to enhance current and future wildlife habitat and forest resilience by increasing plant species diversity and structural complexity in a young Douglas-fir (*Pseudotsuga menziesii*) plantation in the lower portion of the Cedar River Municipal Watershed (CRMW). This project also includes learning objectives of improving species diversity from a conifer dominated to a mixed species stand and tracking the development of Douglas-fir trees grown in open conditions.

Specific restoration objectives include:

- ***Increase tree species diversity to improve habitat for a range of wildlife species and to improve forest health and resilience***. Increasing plant species diversity, including trees and shrubs, will benefit numerous wildlife species and will improve forest resilience to disturbances.
- ***Increase understory species diversity, primarily shrubs, to improve habitat for a range of wildlife species.*** Augmenting the exisiting understory vegetation, which is currently dominated by salal (*Gaultheria shallon*) will improve habitat for a variety of wildlife species.
- ***Increase forest structural complexity to allow for more diverse forest developmental trajectories, incorporate greater species diversity and ultimately simulate a naturally regenerated forest.*** Increasing structural complexity by creating canopy gaps, thinning to varied tree densities, planting to improve species composition, and retaining skips will benefit numerous wildlife species in the short-term, including bats, birds, elk and deer. Over the long-term, the forest will have more diverse species composition and greater structural complexity and therefore will be more resilient to disturbances and will provide better habitat, including the large tree component that will benefit many HCP-listed species that are dependent on old-growth forest characteristics.

Specific learning objectives include:

- ***Evaluate the effectiveness of increasing overstory and understory species composition within canopy gaps and widely spaced thinning treatments, especially with dense salal understory.*** Planting a variety of tree and shrub species after thinning and gap creation to increase species composition will require site preparation and follow-up monitoring and maintenance. We expect that the overstory canopy will be open enough in the thinned areas and gaps that light will not be a limiting factor to survival and growth of planted materials. However, understory competition and ungulate browse may impact survival and growth.
- ***Explore whether different levels of thinning and gap creation result in different developmental trajectories and forest structural conditions over time.*** Including this objective as both a restoration objective and a learning objective is important to make sure that we are managing in an adaptive management context.
- ***Explore whether open-grown Douglas-fir trees will result in larger branches and longer crowns, such that they may provide for future marbled murrelet nesting habitat.*** The key habitat components required for marbled murrelet nesting are: 1) large diameter

trees with large diameter branches in the upper third of the tree, and 2) aerial access to these branches. Currently there is no suitable murrelet nesting habitat in the lower watershed. The project area is one of few areas in the lower watershed where young Douglas-fir trees can grow for several decades with little competition, producing large "wolf-trees" that could potentially provide large nesting branches and easy access to these branches for murrelets. This project will explore over time whether open-grown Douglas-fir trees, including gap edge trees, will indeed provide suitable murrelet nesting habitat.

These objectives will be fulfilled by using two different thinning prescriptions, planting diverse tree and shrub species, retaining higher density skips, and creating small (0.25-acre) gaps throughout the treatment units.

While this project is not designed as an experiment, it is experimental in nature. In order to test the effectiveness of meeting the restoration objectives and to share findings with other forest restoration practitioners, we developed a series of ecological benchmarks. We will monitor certain forest attributes on this project over time and compare the monitoring results to the goals, objectives and benchmarks.

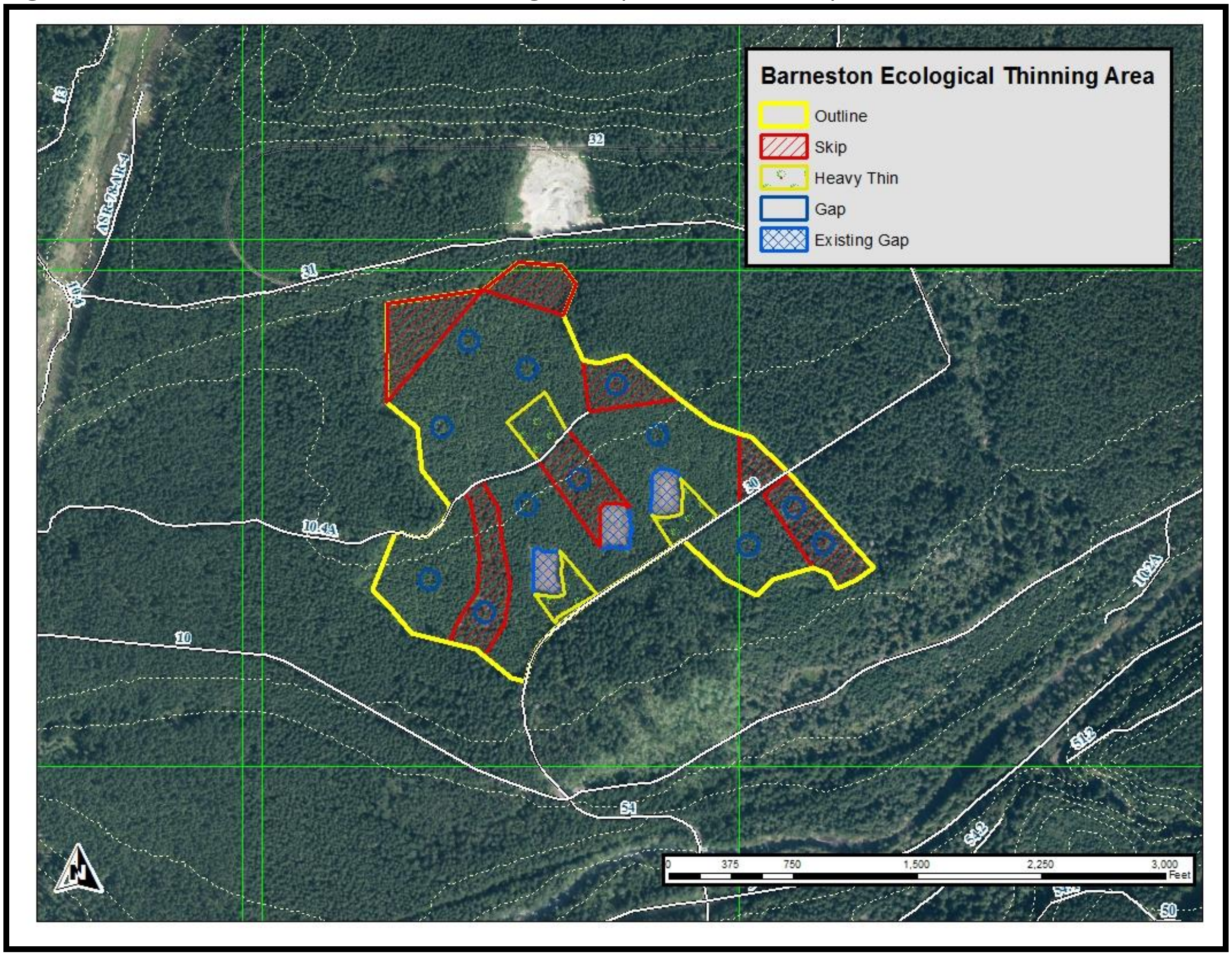
2.0 PROJECT SITE DESCRIPTION

2.1 Project Site Location and Context

The 30-year-old Douglas-fir plantation is located in the lower CRMW, north of the Cedar River near Green Valley. It is near the Green Valley/14 Lakes Habitat Enhancement Project that was completed in 2007. The unit is also near the historical town of Barneston. The total project area roughly 88 acres (Figure 1).

Most of the Green Valley has been identified by the synthesis project and synergy map (Erckmann et al. 2008) as medium or high synergy area (i.e., area where habitat restoration or enhancement would benefit a large number of species), primarily because of the connectivity it provides between key riparian, wetland, and high quality forest habitats. The area is an important link for species using the more differentiated second-growth forest habitat in the lower Taylor River drainage and the riparian forest near the Cedar River to the south, the riparian forest near Williams Creek to the east, and the riparian forest near Rock Creek, the Rock Creek Wetland, and the 14 Lakes ponds to the west.

Figure 1. Overview of the Barneston Douglas-fir plantation, with planned treatments.



2.2 Project Site History

The project site has an extensive forest management history. The primary forest was logged between 1900-1913 and presumably naturally regenerated to a Douglas-fir and western hemlock (*Tsuga heterophylla*) forest. The second-growth forest was commercially thinned in 1980-1982, and most of the hemlock was removed from the stand. On December 23, 1983, the project area experienced a severe wind storm. The unit had significant windthrow and was subsequently salvage-logged, then planted to Douglas-fir. In 1995, the unit was pre-commercially thinned to 300 trees per acre (tpa) resulting in Douglas-fir at 12 foot spacing; all other tree species were removed. The largest maintained trees were 5.5" in diameter.

Three rectangular forest gaps (approximately 1.0 acre each) were made in the project area along the 30 Road in 2011. They were planted with western redcedar, western white pine, shorepine, Garry oak and Douglas-fir from two different seed zones in an effort to assess resilience to climate change. Monitoring the growth of these trees is ongoing.

2.3 Current Conditions

Currently the overstory is dominated by Douglas-fir with occasional red alder (*Alnus rubra*) (Table 2). Understory tree species include some western hemlock, Douglas-fir, red alder, and western redcedar (*Thuja plicata*). Dominant tree height varies from 40 to 80 feet, with an average diameter at breast height (dbh) of 9.0 inches for trees greater than 4.5 inches dbh. Stand density for all trees is 352 trees per acre, while stand density for trees greater than 4.5 inches dbh is 252. These dominant trees are primarily Douglas-fir and comprise 72 square feet of basal area per acre.

Table 2. Trees per acre and average diameter by species of trees greater than 4.5" diameter at the Barneston project site.

Acres	Species	TPA	AVERAGE DBH
88	Douglas Fir	246	9.1
	Red Alder	6	5.0
	TOTAL	**252**	**9.0**

The forest canopy has completely closed in some portions of the units, but in other areas it is open and has natural gaps (Figure 2). Some lower branch loss has occurred due to onset of canopy closure in the dense areas. The portions of the stand that have natural canopy openings have resulted from incomplete stand establishment, recent bear damage, and current root rot pockets. The bear damage and root rot has mainly impacted the Douglas-fir trees, often in patches of three trees or more. The few dominant western hemlock trees seem unaffected by the root rot and appear healthy. In portions of the stand the Douglas-fir tree vigor is low.

Salal dominates the understory, which also includes sword fern (*Polystichum munitum*), red huckleberry (*Vaccinium parvifolium*), salmonberry (*Rubus spectabilis*), deer fern (*Blechnum spicant*), and red elderberry (*Sambucus racemosa*). Vine maple (*Acer circinatum*) is also present. Coarse woody debris was removed during the past salvage operation and is uncommon.

2.4 Soils and Topography

The project area has the Klaus soil type (Figure 3), which is common in this part of the watershed (WA-DNR 2000, http://www3.wadnr.gov/dnrapp6/dataweb/metadata/soils.htm). Klaus is site class 3 with a site index of 109 (Douglas fir at 50 years). It typically supports Douglas fir, western hemlock, and western redcedar. Topography is less than five percent slope, and the area contains no streams or wetlands.

Figure 2. Tree height in the Barneston area.

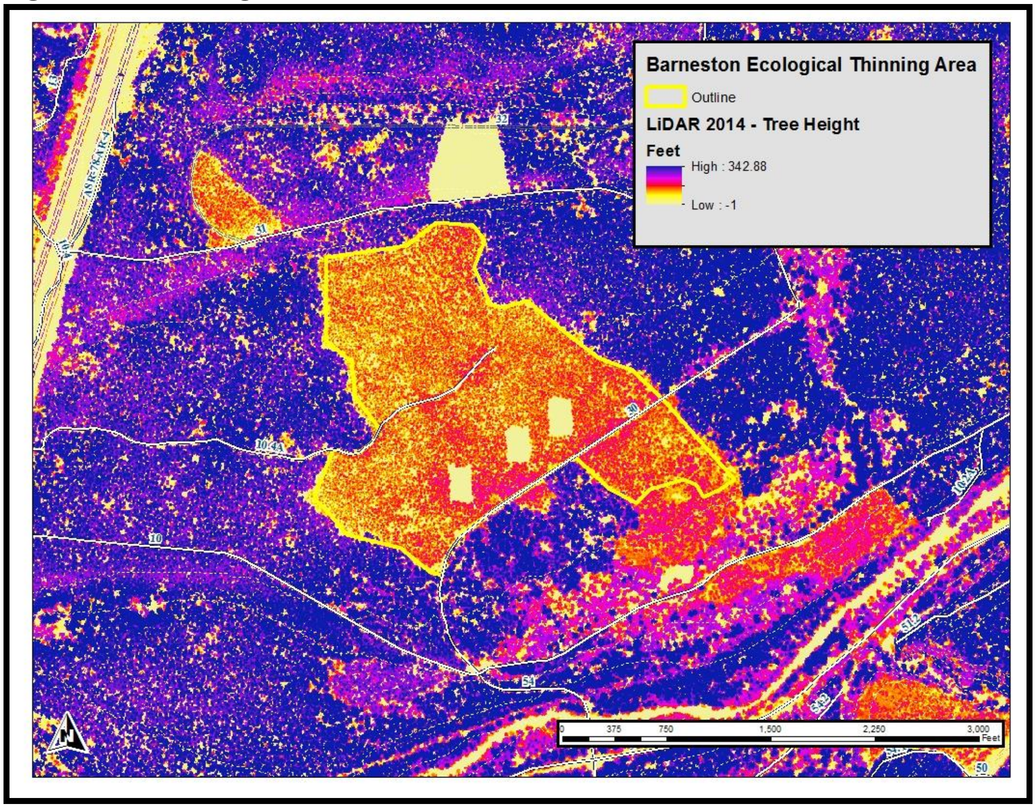
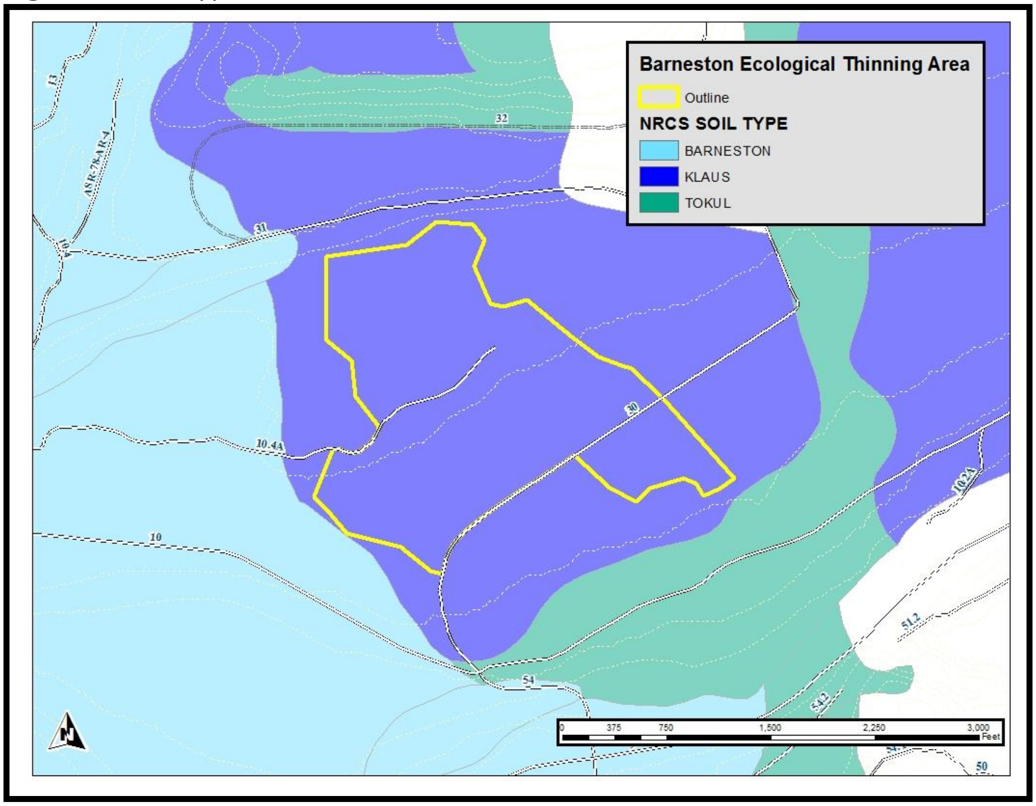


Figure 3. Soil types in the Barneston area.



2.5 Forest Health

Various processes that cause tree mortality of the Douglas-fir trees are occurring in the Barneston project site. Bear damage has impacted individual trees in a relatively dispersed manner. Low vigor and mortality from root disease is evident in other areas, particularly on the Douglas-fir. Investigation of dead trees show classic signs of laminated root rot caused by *Phellinus weirii*, including chlorotic and thinning foliage, cone stress crops, fallen trees, and laminating wood layers on stumps and tree butts. Other tree species, such as western hemlock, appear healthy relative to the Douglas-fir, except for the occasional dead western hemlock with evidence of *Armillaria* fungus (species and strain undetermined). Where Douglas-fir mortality has occurred, patches of trees are killed, creating canopy openings. Planting diverse tree species in the project area will increase the diversity and therefore the resilience to forest disturbances in the future.

2.6 Cultural Resources

The Barneston Forest Habitat Restoration Project site is so-named because it is in the vicinity of the historical lumber town of Barneston that existed between 1892 and 1924, at which time it was condemned by the City of Seattle and moved to the current town of Selleck. The town was named in 1901 after John J. Barnes, and it included a mill that was founded by Kent Lumber Company, a railroad, a post office, many houses and a Japanese camp. The Washington State Department of Archeological and Historical Preservation has not yet determined the eligibility of the Barneston town site for placement on the National Historic Register. A comprehensive survey of the townsite has not occurred, but cultural resources that may remain include dump sites, building foundations, fencing material, a timber crib dam at the mill pond, and glass, ceramic and metal fragments. The boundaries of the Barneston Forest Habitat Restoration Project have been placed such that impacts to cultural resources associated with the town site as well as the CRMW cultural resource probability layer are avoided, and key forest areas are skipped (no treatment) for cultural resource protection.

3.0 PROJECT JUSTIFICATION

There are several reasons to implement this Barneston Forest Habitat Restoration Project. This project is in a high synergy area, it complements adjacent upland forest habitat restoration efforts, it presents a restoration opportunity and a learning opportunity to conduct forest restoration in a young Douglas-fir stand, and it overlaps with MIT objectives to improve ungulate habitat in the winter range of the CRMW. These reasons are described in more detail below.

3.1 Synergy Ranking

The Green Valley area has a high synergy ranking because it is a connectivity area between the high quality second growth forest in the lower Taylor Basin and Walsh Lake. It is also adjacent to important riparian and aquatic habitats, including the Cedar River and 14 Lakes. Increasing forest plant species diversity and structural complexity in the young stands of the Barneston project area, while facilitating more rapid development of the large tree habitat component, will benefit numerous wildlife species.

3.2 Adjacent Forest Restoration Projects

This project will complement other habitat enhancement projects that have already been installed in the vicinity. Immediately adjacent to this project, the Green Valley/14 Lakes Project (Nickelson et al. 2007) created or enlarged natural canopy gaps, created snags and logs, and planted native trees and shrubs within Douglas-fir forest stands that are approximately 70 years old. This project is also near the BPA ROW that provides foraging habitat for elk and deer. Creating canopy gaps and widely thinned stands will increase the habitat value for ungulates in the short term.

3.3 A Restoration and Learning Opportunity

There is little young forest in the lower watershed. Most of this forest was originally logged either using a clear-cut or variable retention method, then thinned to evenly–spaced Douglas-fir using either a 12x12 foot spacing (~300 tpa) or a 15x15 foot spacing (~200 tpa). This project provides an opportunity to improve the species composition, create small-scale (0.5-5 acres) patterns of variability, and encourage open-grown trees in a young forest. If the forest responds favorably to the thinning and planting treatments, the other young stands in the lower watershed may also be thinned and planted to meet similar restoration goals.

The Barneston project area is a good place to experiment with enhancing future murrelet habitat because there is limited young forest available in lower watershed in which we can establish an "open grown" pattern in first 50 years in the life of the tree. It has been postulated (Tappeiner and Poage 2002) that in early stand development trees that grow with reduced competition for nutrients and light are more likely to develop large tree sizes found in primary Douglas-fir forests. Research has also shown that crowns of trees grown in widely spaced stands tend to be longer and wider, with larger diameter branches, than crowns of trees grown in dense stands (Turnblom and Collier 2003). It is unknown, however, whether this growth pattern will result in large diameter branches in the upper one-third of the canopy (preferred marbled murrelet nesting habitat). Providing the opportunity for open-grown trees will allow us to evaluate whether this type of thinning prescription will accelerate development of that large branch habitat component critical for marbled murrelet nesting. Both thinning treatments (see section 4.0) are expected to provide for rapid diameter and crown growth of the remaining Douglas-fir trees.

In addition, creating numerous small gaps and retaining skips will allow edge trees to also develop a large branch component. Because the gaps will be planted with deciduous species such as red alder and big-leaf maple (*Acer macrophyllum*), they are designed to last at least 100 years. These gaps should not only provide long-term habitat for many species that utilize deciduous foliage and its associated understory, but may also provide good future access to the branches of the adjacent conifers for nesting murrelets. The gaps should not be filled by adjacent conifer branch extension and will provide sufficient light for big-leaf maple and red alder to persist for many decades. Gaps dominated by big-leaf maple should persist for approximately 120 years until the maples die naturally and are replaced with native shade-tolerant conifer species such as western redcedar (*Thuja plicata*) and western hemlock.

3.4 Compatibility with MIT wildlife objectives

Providing numerous canopy gaps and widely spaced trees in some of the thinning treatments should also enhance forage habitat for species like deer and elk in the short-term because it will provide light for understory plant species. The project location fits within a complex of current and potential elk forage projects ranging from potential forage plots created by the Muckleshoot Indian Tribe under the BPA right-of-way to the canopy gaps created in the Green Valley/14 Lakes project.

4.0 PROJECT DESIGN

The project design is developed to incorporate current conditions and logistical constraints in order to best meet the restoration and learning objectives as described in Section 1. There are four treatment prescriptions, light thin (to 100 TPA), heavy thin (to 50 TPA), 0.25-acre gaps, and untreated skips. Gaps are intended to provide open areas both for the regeneration of diverse tree species and ungulate forage. Skips are intended to buffer the project, as well as areas already undergoing patch dynamics (e.g., wet areas and places infected with root rot). Heavy thin areas are intended to be adjacent to existing skips and provide a mix of species diversification opportunities as well as open growth for maintained Douglas-fir trees. Light thin areas, or the majority of the treatment area, are still substantially altered to maintain tree growth and species diversification. All of the treatments will be visible from the 30 Road. Following the tree overstory treatment, planting to augment species composition will be a vital project component.

4.1 Overstory Prescriptions

The project will include four treatments (Table 1): gaps (0.25 acre), moderate thin (100 tpa), heavy thin (50 tpa), and skips (no further treatment, remaining at 246 tpa). Gaps will be approximately 0.25-acre, while thinning and skips will vary from 1.5 to 4.5 acres. Both gaps and skips are designed to be long-lasting structural features within the units.

Table 1. Treatments acres for the Barneston project.

			Pre-Treatment		Post-Treatment		Volume to be Removed		
Treatment		**Acres**	**TPA**	**BA/acre**	**TPA**	**BA/acre**	**BA**	**Tons**	**MBF**
Thin	Heavy	4.4	246	117	50	41.8	331	133	20
	Light	54.5	246	117	100	70.3	2,545	904	154
Gap	New	3.1	246	117	0	0	363	165	21
	Existing	3.3	0	0	0	0	0	0	0
Skip		22.6	246	117	246	117	0	0	0
Total Area		**87.9**					**3,239**	**1,202**	**195**

<u>Gaps</u>

The 0.25 acre gap size was chosen to be larger than the median gap size of about 0.2 acres found in old-growth Douglas-fir forests (Spies et al 1990), so that the gaps will persist and provide long-term structural complexity as well as increased light to adjacent trees. We will plant red alder near the edges of the gap so that the increased soil nitrogen will be available for use by the adjacent Douglas-fir trees. We will plant big-leaf maple and black cottonwood (*Populus balsamifera*) (where appropriate) in the center of the gaps so they will have the maximum amount of light for long-term persistence. These deciduous trees should provide sufficient light for a diverse understory vegetation community to develop and persist.

- Gap Prescription – Cut all Douglas-fir trees within the pre-marked gap area, leaving marked trees along gap edges standing.

Light Thin

Light Thin Prescription - Thin to 100 TPA Douglas-fir, using approximately even spacing of 21 feet, retaining the largest trees within the spacing requirement (± 5 feet).

Heavy Thin

Heavy Thin Prescription - Thin to 50 TPA Douglas-fir, with approximately even spacing of 30 feet, retaining the largest trees within the spacing requirement (± 5 feet). These leave trees will be pre-marked with blue paint.

Skips

Skips are included to increase structural complexity within the units and also to provide a basis for comparing the moderate and heavy thinning treatments over time. The various sizes and shapes of skips were designed to provide a large amount of edge where the increased light should result in increased bole and branch growth.

- Skip Prescription – No treatment, so final tree count will be approximately 250 TPA.

4.2 Planting Prescriptions

The purpose of planting is to increase the tree and shrub species diversity in the project site. In the thinning areas, the planting will be done at the ½ acre spatial scale in order to increase the structural complexity of the larger thinning treatment areas.

Site preparation before planting is contingent upon residual slash loading and understory shrub condition after thinning. Given the heavy salal understory, site preparation may need to occur prior to or simultaneous with planting. This site preparation may be accomplished with a mechanized “hy-gro tiller” that churns the planting site and effectively reduces salal competition for 3-5 years. If costs exceed available funds, then hand scalping will be the alternate planting method.

- Gap planting - Plant with deciduous trees (big-leaf maple, red alder, and black cottonwood), and smaller portions of western white pine (*Pinus monticola*) and western redcedar. Plant the alder along the gap edges and big-leaf maple in the center.

- Moderate Thin Planting - This treatment will be planted with 100 tpa of a variety of native deciduous and conifer species to bring the final tree count to 200 tpa. If needed to provide sufficient light for planting, a few of the remaining Douglas-fir trees may be girdled during planting, to create small snags.
- Heavy Thin Planting - These thinned areas will be planted with 30 tpa of predominately native deciduous species such as red alder and big-leaf maple, with a few western redcedar to bring the final tree count to 75 tpa, allowing for mortality.

All western redcedar will be planted with browse protection that will be "lifted" every 1-2 years to protect the leader from ungulate browse.

4.3 Implementation Logistics

Since the topography of the project is almost completely flat and the trees being harvested are relatively small, the most efficient method of timber harvest is mechanized harvester capable of felling, limbing, and bucking. Slash will be placed in front of the harvester on designated skid trails. Yarding will likely be done by a ground based forwarder with log decks stacked along the 30 Road and 10.4A Road.

Volume estimates for the project as a whole appear in Table 1. Approximately 59 acres will be thinned and three acres will be cut as gaps. We anticipate that approximately 9,600 trees will be cut, which is roughly 195 thousand board feet (MBF) in volume. A 10% reduction for damage, missed rot, and sample error brings the estimated total volume available for sale to 175 MBF.

Gaps were distributed non-randomly throughout the unit, while skips were placed non-randomly to protect sensitive areas. These layouts may be modified to accommodate logistical concerns after consultation with contractors. All units were designed such that no thinning will occur within 200 feet of a stream.

5.0 EVALUATION OF POTENTIAL NEGATIVE EFFECTS

We anticipate few, if any, long-lasting negative ecological effects from this project. The primary negative effects will likely be:

- soil disturbance and compaction if ground-based equipment is used; and
- a reduction of certain fungi species that require a closed canopy forest.

We will minimize ground disturbance and compaction by restricting the number of corridors and passes that equipment can make along each yarding corridor. Because the canopy is only closed in portions of these units, these fungi may not develop for a longer period of time in the thinned and gap areas than if the units were left untreated.

The created canopy gaps will be relatively small and should not facilitate more wind-throw than would naturally occur. Larger gaps could potentially increase the risk of windthrow in this area that experiences routine wind storms. Plus larger gaps would not contribute to the long-term objective of accelerating murrelet nesting habitat, since there would be fewer trees remaining to develop large branch structure. Most of the watershed consists of very dense forests, so those few wildlife species that prefer a dense canopy have an abundance of nearby habitat and will not be negatively impacted by providing a more open forest in this small project area (less than 0.1% of the watershed).

6.0 EVALUATION OF COSTS VERSUS BENEFITS

This project is being conducted as part of the HCP ecological thinning program. The general cost/benefit analysis for this type of project has already been completed, and can be viewed in the HCP.

We evaluated the three primary options for this project:

1. No treatment,
2. Hand-thinning only, leaving all slash *in situ*,
3. Thinning and yarding using ground-based equipment such as a processor/forwarder,
4. Thinning using a processor or hand falling and cable yarder system to remove designated logs from the site.

Option 1 – We rejected the first option because it will not enhance current and future wildlife habitat or allow us to test whether this type of thinning will accelerate development of old forest conditions and potential murrelet nesting habitat.

Option 2 – The second option is a safety hazard for restoration thinning crews because the trees are larger diameter (8-12 inches dbh, >45 ft tall) than they normally cut (<6 inches dbh). Leaving all slash on the forest floor would make development of a diverse understory vegetation community, access for planting and monitoring, and locations for planting more difficult.

Option 3 – The third option is feasible and probably most cost-effective, but carries risk of soil compaction. The units are well situated for ground-based equipment (cut-to-length processor and forwarder) because the ground is flat and the units are all adjacent to roads, providing easy access for equipment. Cutting the trees with a processor allows for easy directional felling, minimizing residual tree damage. Yarding designated logs will provide access for future planting and monitoring. If a portion of the logs are sold, that revenue will help offset operational costs. Forwarders will be able to travel on the slash over designated skid trails to minimize compaction and the area affected.

Option 4 – A cable yarding system using intermediate supports to provide full suspension would have advantages over ground-based equipment in their ability to minimize soil compaction, especially if hand falling is done rather than mechanized falling. However, the cost of a cable yarding system may be higher than using ground-based equipment.

We will not be able to clarify exact project costs until after we meet with contractors to discuss logging costs and potential revenue from selling a portion of the logs. We expect that if any logs are sold, the revenue will not offset all of the operational costs. We do not expect the planning or monitoring costs to be offset by log sales.

The expected benefits of this project are environmental. They include greater plant species diversity, increased forest structural complexity, and potentially accelerating development of marbled murrelet nesting habitat. This project should improve the habitat for numerous wildlife species over both the short and long terms.

7.0 COORDINATION WITH OTHER PROJECTS

This project complements the following projects:

- The Green Valley/14 Lakes forest habitat restoration project (gap, snag, and log creation, plus planting for species diversity).
- The gap creation/planting project in the forest near the ROW south of the Cedar River
- The BPA ROW clearing plan in which numerous snags were created, log piles were created, and down wood retained.
- Several invasive species removal projects in and near the BPA ROW.
- The to-be-determined experimental marbled murrelet habitat enhancement project in the lower watershed

Taken collectively, all of these projects are expected to significantly enhance wildlife habitat in and near the BPA ROW.

8.0 PERMITTING AND APPROVALS

An FPA will be needed because harvesting equipment will be used and logs will be yarded out of the units and sold. If logs from this project are sold, the total amount will be less than 250,000 board feet, so this sale could be covered under current Seattle City Council approval (Ordinance 121040). However, this project was also specified in the five-year ecological thinning ordinance (#124068) that was approved in 2012.

9.0 CULTURAL RESOURCES EVALUATION

The project area is considered low probability of having cultural resources, and consequently will not require a cultural resources survey. SPU staff will monitor for cultural resources during implementation, and the contractors will be oriented to the historic context of the site.

10.0 IMPLEMENTATION

Forest Ecology work group staff will lay out the project boundaries. A contractor will be selected to implement the project. We anticipate that implementation will occur in 2015. Planting will likely use bare-root stock and occur in late winter of 2015.

11.0 MONITORING

Tree growth and understory response will be tracked using photopoints and small measurement plots (tree attributes only) in the two thinning treatments and skip treatments. Sample point locations will be determined and installed after project implementation and sampled at 5, 10, and 20 years post-treatment. As-needed maintenance and monitoring of the planted seedlings will occur every 2-3 years until they are above competing understory vegetation and ungulate browse.

12.0 REFERENCES

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